CE 570: Advanced Structural Mechanics

HOMEWORK 1

Part 1: Due ONLINE on blackboard on at 11:30am Saturday, Sep 2, 2016
Part 2: Due ONLINE on blackboard **and** in class at 11:30am Wednesday, Sep 6, 2016

Part 1 guidelines:

- Work your solution **independently** and **neatly,** on **one side** only on college-rule / engineering paper.
- You may use any combination of mix of **black / blue / green** pens or pencils (but not red).
- Start every problem on a **new** page.
- All **diagrams** must be drawn **neatly** using a straight edge.
- All work should be presented in a **logical sequence**.
- **Scan & submit your homework online** on Blackboard as a **single pdf-file**.
- **Do not email** your homework to the instructor.
- Make sure that your **scan is good quality** and your pdf-file is **clearly readable.**
  Cell-phone / camera pictures of your homework will **not** be accepted / graded.
  Illegible or light scans will **not** be graded**.**
- All the scans must be in a **single pdf-file**. To edit, combine or create pdf-files you may use any of the following freely software programs:
  - *PDF Architect* and/or *PDF Creator* (http://www.pdfforge.org/)
  - *Primo-pdf* (http://www.primopdf.com)

  Try to make sure that your pdf-file size is not more than 5MB (Maximum 10MB).
- The **file name** of your scan must be in the format "`HW??-FirstLast-1.pdf`" where "`??`" is the HW number, "`First`" and "`Last`" are your first and last names, and the "`-1`" denotes Part 1. e.g. `HW01-ArunPrakash-1.pdf`.

Part 2 guidelines: (Work in red pen only)

- The solutions will be posted online at 5pm on Friday (on the due date for Part-1).
- Based on the posted solutions:
  - Correct any errors in your work and revise your solution. If you made any errors, comment why you think you made the error(s) and how you will avoid such error(s) in the future.
  - For each problem, list the most important concepts that you learned.
  - Briefly comment how you may be able to verify / cross-check your revised solution and the posted solution. Also comment, if you think that the posted solution is incorrect.
- You may add pages if necessary, but do **not** submit an entirely new homework file for Part 2.
- **Scan & submit your revised homework online** on Blackboard as a **single pdf-file**.
- The **file name** of your scan must be in the format "`HW??-FirstLast-2.pdf`"

Grading & Solutions:

- **Part 1**: 10 points = 3 problems x 3 points each + 1 presentation point
  - For Part-1, we will grade based only on your effort: You can get full 3 points for a problem, if you made an **honest independent effort** (even if your solution was incorrect!).
- **Part 2**: 5 points (for revisions and comments)
- Total: **15 points**

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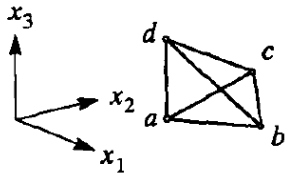
HW Guidelines:

- Revise multi-variate calculus: line, area and volume integrals, partial derivatives etc.
- Read Chapter 1 (very carefully!) from *Fundamentals of Structural Mechanics* by KD Hjelmstad.
- Work your solution neatly, starting all the problems on a new page.
- Be **very precise** with notation. You will lose ½ point for every notational error that you make. So, if you make 10 notational errors in 1 question, you will receive a *zero* score even though your solution may have the right idea.

Problem 1: (5 points)

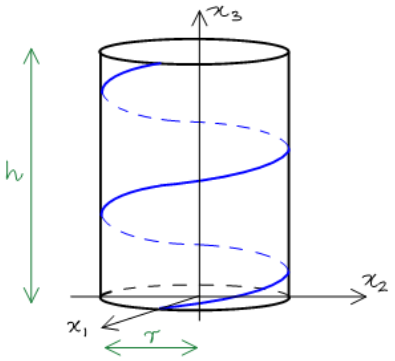
Solve Problem 4 from the textbook.

4. Let the coordinates of four points *a, b, c* and *d* be given by the following position vectors *a*=(1, 1, 1), *b*=(2, 1, 1), *c*=(1, 2, 2), and *d*=(1, 1, 3) in the coordinate system shown. Find vectors normal to planes *abc* and *bcd*. Find the angle between those vectors. Find the area of the triangle *abc*. Find the volume of the tetrahedron *abcd*.



Problem 2: (5 points)

As a retrofit design for an aging column of height h and radius r, a mesh of spiraling external reinforcement is proposed. A particular strand in the mesh is shown in the adjacent figure. Assume that each strand makes n complete revolutions uniformly around the column over its height.

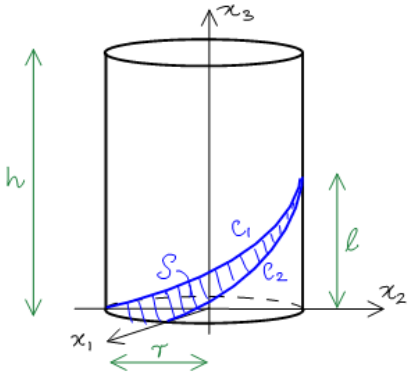


(a) Derive parametric expressions to mathematically define the curve for the particular spiraling strand shown in terms of a single parameter s.
Hint: You may use θ instead of s if that helps you visualize the curve better.

(b) Derive an integral expression for the total length of the reinforcing strand shown in terms of the given variables and evaluate the integral analytically, if possible.

Problem 3: (5 points)

As a retrofit for a concrete column spalling at its base, a spiraling FRP patch $\mathcal{S}$ is proposed as shown. The boundary of the patch is defined by the base of the column and the curves C_1 and C_2 as shown. Curve C_1 traverses between the points (0, -r, 0) and (0, r, l) wrapping around the column for a half-turn and the curve C_2 traverses between the points (r, 0, 0) and (0, r, l) wrapping around the column for a quarter-turn as shown in the adjacent figure.



(a) Derive parametric expressions to mathematically define the patch surface $\mathcal{S}$ shown in terms of two parameters (s, t).
Hint: You may use (θ, z) instead of (s, t) if that helps you visualize the patch better.

(b) Derive an integral expression for the total area of the patch in terms of the given variables and evaluate the integral analytically, if possible.